EM&V Methods: A Time for Uniformity

Hossein Haeri, Ph.D., and Tina Jayaweera, Ph.D., Cadmus, Portland, Oregon
Michael Li, United States Department of Energy, Washington, D.C.

ABSTRACT

Current practices in energy-efficiency evaluation, measurement, and verification (EM&V) in the United States allow for multiple methods for calculating and verifying savings from energy-efficiency measures. Efforts to standardize these methods at the state level have been considerable, resulting in evaluation protocols and the creation and adoption of technical reference manuals (TRMs) for calculating savings in many jurisdictions. In 2011, the United States Department of Energy (DOE) undertook an effort to bring uniformity to the way energy savings are determined by launching the Uniform Methods Project (UMP).

The project's primary goal was to develop and distribute a set of standard methods for calculating and verifying savings through clear, step-by-step procedures, thus streamlining EM&V, allowing for comparison of savings across similar measures, reducing uncertainties associated with savings, and strengthening the credibility of energy efficiency as a reliable alternative to traditional power-generation resources.

The UMP, organized and funded as a two-phase undertaking, is now nearing the end of its second phase. Protocols for 15 measures, estimated to account for more than three-quarters of energy-efficiency savings reported by program administrators nationwide, have been completed. These protocols are accompanied by a number of complementary documents covering technical, methodological topics such as sample design and data-collection techniques, and net-to-gross (NTG) calculations that apply to all measures. Together, these protocols are expected to provide a common source for widely accepted EM&V practices.

This paper describes the goals, processes, and outcomes of the project; reports its progress to date; and highlights reactions from the various stakeholders in the energy-efficiency industry in the United States.[1]

Introduction

Investment in ratepayer-funded energy efficiency in the United States has grown dramatically in recent years. Energy efficiency now accounts for a significant share of electric generation resource portfolios of utilities in many states. Energy-efficiency resource standards (EERS) and saving targets mandated by regulators are now in effect in 26 jurisdictions—and are being considered in several more. In several states, energy efficiency has been recognized as the "fuel of first choice" and is expected to satisfy 10 percent or more of forecast demand for electricity within a few years.[2] This greater reliance on energy efficiency as a means of meeting future energy-resource requirements has raised concerns about reliability of the expected savings for meeting utilities' future load obligations.

[1] The complete report on Phase 1 of the project is available at: http://www.nrel.gov/docs/fy13osti/53827.pdf

[2] See *Energy Efficiency Resource Standards: A Progress Report on State Experience*, American Council for an Energy Efficiency Economy (ACEEE), Report Number U112, June 2011.

The UMP originated from a scoping study, sponsored by the State and Local Energy Efficiency Action Network's (SEE Action) EM&V Working Group.[3] One of the objectives of that study was to assess how practices in determining and evaluating ratepayer-funded energy-efficiency programs might be supported by developing a database of standardized, region-specific, *ex ante* algorithms and associated savings estimates for conventional electric and natural gas energy-efficiency measures.

A comprehensive survey of available databases, conducted as part of that study, identified 17 sources for calculation methods and *ex ante* values for measure savings covering 21 states and the District of Columbia. A detailed review of 20 common measures across the 17 TRMs indicated marked inconsistencies in methods and widely varied technical assumptions used for estimating savings. Even in cases where the same algorithms were used, the baseline assumptions were different.

These results pointed to the need for creating a set of standard methods for estimating savings from energy-efficiency measures based on consistent algorithms and commonly acceptable procedures for evaluating the load of energy-efficiency measures.

The Case for Uniformity

The primary goal of the UMP was to address these shortcomings by developing and making publicly available information on how the savings from energy-efficiency measures are calculated and how the achieved savings are verified. This material would help reduce the uncertainty associated with determining energy-efficiency savings and offers guidance for implementing the techniques and interpreting results. Critically, such resources would also provide a basis for comparing the impacts of energy-efficiency policy initiatives across the country. More specifically, the DOE envisioned the following goals for the project:

- Offer guidelines that help strengthen the credibility of energy-efficiency program savings calculations.
- Provide clear, accessible, step-by-step protocols to determine savings for the most common energy-efficiency measures.
- Support consistency and transparency in how savings are calculated.
- Reduce the development and management costs of EM&V for energy-efficiency programs offered by public utility commissions, utilities, and program administrators.
- Allow for comparison of savings across similar efficiency programs and measures in different jurisdictions.
- Increase the acceptance of reported energy savings by financial and regulatory communities.

While these protocols are applicable to a wide range of situations, their initial audience would be stakeholders in states where energy efficiency is relatively new (or is newly expanded). These protocols would also serve policymakers and program administrators in at least four ways:

1. Providing a reliable basis for evaluating the effectiveness and viability of energy efficiency, thus offering regulators a basis and the means for both assessing the prudency of ratepayer-funded investments and determining compliance with savings targets.

[3] Scoping Study to Evaluate Feasibility of National Databases for EM&V Documents and Measure Savings, *Evaluation, Measurement and Verification Working Group* the State and Local Energy Efficiency Action Network, Prepared by The Cadmus Group, *June 2011.* For information on the SEE Action see: www.seeaction.energy.gov

2. Offering utility resource planners and program implementers greater certainty about program performance, and reducing planning and regulatory compliance risks.
3. Supplying independent EM&V contractors with a standard set of tools and techniques that would enhance the credibility of their findings and ultimately reduce evaluation costs.
4. Providing a resource for educating EM&V practitioners in the use of algorithm-based methods for calculating savings in TRMs.

By making the methods for calculation and verification of savings more transparent and uniform, these protocols seek to increase the reliability of energy-efficiency results reported by program administrators and implementation contractors. This will help mitigate the perceived risks of investing in energy efficiency and stimulate greater participation.

About Savings

Savings from energy-efficiency measures have been defined in different ways, depending on the needs of the various participants in the energy-efficiency industry. The UMP protocols use commonly understood definitions to differentiate the five ways savings are reported at the design, implementation, and evaluation stages of a program's life cycle.[4] These are:

- Projected Savings: values reported by a program implementer or administrator before the efficiency activities are completed.
- Gross Savings: changes in energy consumption that result directly from program-related actions taken by participants in an energy-efficiency program, regardless of why they participated.
- Claimed (Gross) Savings: values reported by a program implementer or administrator after the implementation activities have been completed.
- Evaluated (Gross) Savings: values reported by an independent, third-party evaluator after the efficiency activities and impact evaluation have been completed.
- (Evaluated) Net Savings: changes in energy use attributable to a particular energy-efficiency program. These changes may implicitly or explicitly include the effects of factors such as freeridership, participant and nonparticipant spillover, and induced market effects.

The five definitions of savings and their relationships are shown in Figure 1. The UMP protocols focus primarily on estimating evaluated gross first-year savings, except where estimates of net savings may be derived as part of the same method.

[4] For more complete descriptions see the State and Local Energy Efficiency Action Network. 2012. *Energy-Efficiency Program Impact Evaluation Guide*. Prepared by Steven R. Schiller, Schiller Consulting, Inc.

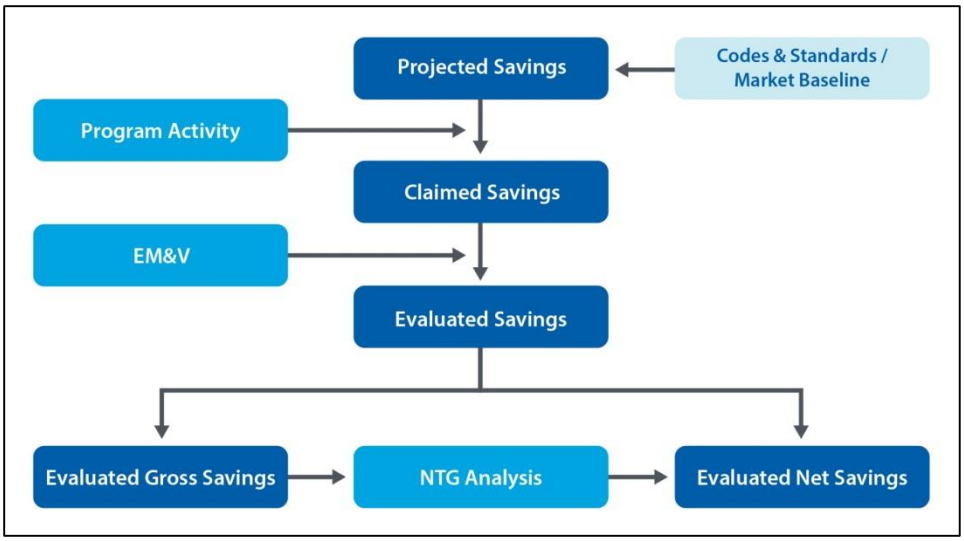

Figure 1. Types of Savings from Energy-Efficiency Measures use in UMP

Each protocol offers easy-to-follow procedures based on commonly accepted methods for a core set of energy-efficiency measures found in most portfolios of ratepayer-funded program portfolios. The material in each protocol is structured similarly and provides the following information:

1. Measure Description: a brief description of the measure(s) covered by the protocol.

2. Application Conditions of Protocol: details on what types of delivery channels or program structure are or are not covered by the protocol.

3. Savings Calculations: the prevailing algorithm(s) needed to estimate energy savings with explanation of parameters included.

4. Measurement and Verification Plan: the recommended approach, including the IPMVP option, for determining values for the parameters required in the savings calculation.

5. Sample Design: overview of considerations on how to segment the population to provide a representative sample for evaluation; in some protocols, this is discussed in conjunction with the M&V plan.

6. Other Evaluation Issues: any additional information deemed pertinent by the author and/or reviewers, including brief discussions of persistence or NTG considerations; often this information is supplemented by the crosscutting protocols.

The UMP protocols do not provide set values for energy savings or assumptions used in calculating savings. The widespread use of these protocols, however, is expected to provide a common analytic foundation for determining “deemed” values based on inputs appropriate for a program’s particular circumstances. The protocols do not prescribe specific criteria for either statistical confidence or the accuracy of savings estimates, because such thresholds are assumed to be determined by their unique objectives and priorities of the protocols’ users. Instead, the protocols provide a structure for deciding on and applying such criteria consistently across measures and programs.

Project's Organization

The UMP was designed to be as inclusive as possible of the full spectrum of stakeholders in energy efficiency, to facilitate the final appeal and acceptance of the work products by taking the following steps:

1. Project Oversight by a Variety of Stakeholders: A project steering committee made up of regulators, program administrators, energy-efficiency policy specialists and industry experts provided general direction and guidance for the project.

2. Authorship by Experts: Nationally recognized experts on specific energy-efficiency measures and technologies drafted each protocol.

3. Review by Technical Advisory Groups: Two technical advisory groups—one focusing on the validity of the protocols and the other on applicability—reviewed drafts of the protocols. Each member provided comments on one or more protocols. These advisory groups included experts conducting EM&V throughout North America.

4. Review by Stakeholders: The protocols were subject to a review process that enabled stakeholders to provide feedback before the protocols were released in their final form.

The project was managed jointly by the National Renewables Energy Laboratory (NREL) and Cadmus, a consultancy providing services in energy, water and natural resources. As the prime contractor, NREL was responsible for forming and coordinating the steering committee and managing the public review process. Cadmus, working closely with the technical advisory groups and technical experts, managed the technical aspects of the project (Figure 2).

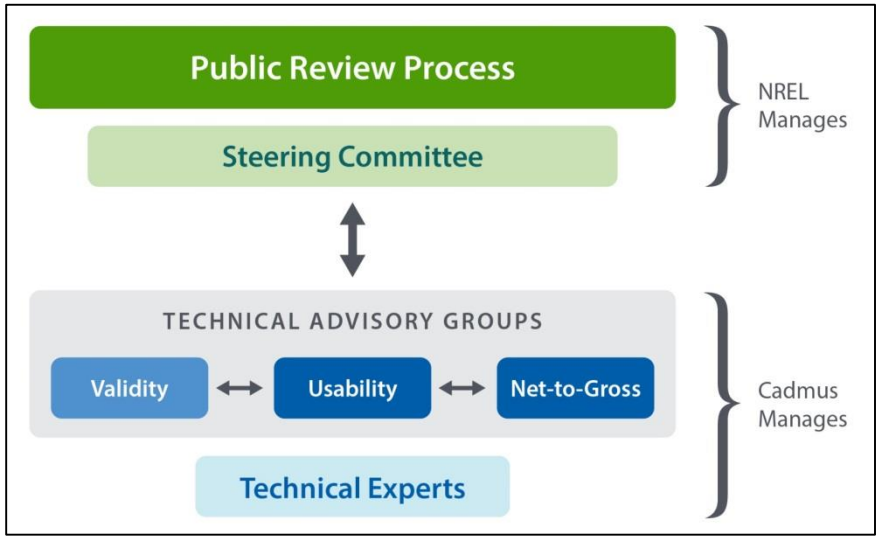

Figure 2. Organization of the Project

The Foundation

The protocols developed under the UMP are based on long-standing EM&V practices, and their methods conform to well-established engineering and statistical principles. They draw from and build on a number of previous attempts to develop comprehensive, systematic approaches to estimating the impacts

of energy efficiency. Several of these protocols were developed to address specific policy objectives, such as the verification of utility program savings, the determination of savings from special performance contracts, and environmental compliance. In addition, a number of protocols have been developed to address specific EM&V requirements in certain jurisdictions (such as California and the Pacific Northwest).

A valuable companion document to UMP protocols is the *SEE Action Energy Efficiency Program Impact Evaluation Guide*. It provides both an introduction to and a summary of the practices, planning, and associated issues of documenting energy savings, demand savings, avoided emissions, and other non-energy benefits resulting from end-use energy-efficiency programs. Designed to be consistent with the *SEE Action Energy Efficiency Program Impact Evaluation Guide*, the UMP protocols are more detailed and specific for particular measures and projects.

The EM&V methods described in the UMP protocols draw upon the International Performance Measurement and Verification Protocol (IPMVP).[5] The methods recommended for each measure correspond closely with one of the four broad measurement and verification options identified in IPMVP, which are frequently cited in most evaluations of energy-efficiency programs:

1. Partially measured retrofit isolation
2. Retrofit isolation
3. Whole facility
4. Calibrated simulation

The UMP protocols builds upon the IPMVP options by adding detail and describing specific procedures for application to measure-, program- and portfolio-level evaluations. To this end, each protocol clearly identifies the IPMVP option with which it is associated.

Scope of the Project

The UMP was conceived as a two-phase undertaking and is now nearing the completion of its second phase. Phase 1 produced protocols for seven measures, which are primarily applicable to residential and commercial facilities, and a set of supplemental cross-cutting documents, covering methods for EM&V activities applicable to all measures in most applications. These resources help extend the measure-specific method for determination of savings to evaluating whole programs. In Phase 2 of the project, protocols for eight additional measures and a cross-cutting guide for the analysis of NTG have been drafted and are now being reviewed for publication in the third quarter of 2014 (Table 1).

The measures included in the project were selected because they: (1) represent a diverse set of end-uses in the residential and commercial sectors, (2) are present in most jurisdictions, and (3) have a significant remaining savings potential. The final set of measures covered represents a significant share of the available technical and economic energy-efficiency potential in most jurisdictions.

For each energy-efficiency measure, the protocol explains the underlying technology, the end uses affected by the measure, the method for calculating the measure's savings, and the data requirements. Also, each protocol attempts to provide a sufficient level of detail without being overly prescriptive, allowing flexibility and room for professional judgment. The measure-specific protocols are supported and complemented by separate chapters that discuss technical issues and topics common to all measures.

[5] Energy Valuation Organization (EVO), International Performance Measurement and Verification Protocols, Concepts and Options for Determining Water and Energy Savings, Vol. 1January 2012.

Table 1. Protocols Completed Under Phases 1 and 2 of UMP

Phase 1	
Energy-Efficiency Measures	***Cross-Cutting Methods***
Refrigerator recycling Commercial lighting Commercial lighting controls Residential lighting Residential furnaces and boilers Commercial unitary and split system air conditioning equipment Whole-building retrofit	Sample design Survey design Metering Calculation of peak impacts Other evaluation topics (including rebound and persistence of savings)
Phase 2	
Energy-Efficiency Measures	***Cross-Cutting Methods***
Chillers Commercial new construction Compressed air systems Data centers HVAC controls Residential behavior-based programs Retro-commissioning Variable frequency drives Revision: residential lighting	Net savings: methods and practices

Supplemental Provisions

The UMP protocols are designed to represent approaches for providing accurate and reliable estimates of energy-efficiency savings that draw upon best practices without undue cost burdens. However, the UMP protocols do not offer recommendations regarding the levels of rigor and the specific criteria for accuracy of the savings estimates. Those issues are largely matters of policy, ease and cost of data acquisition, and availability of resources. To provide maximum flexibility, each protocol contains recommendations for alternative, lower-cost means of deploying the protocol, such as relying on secondary sources of data for certain parameters and identifying guidelines for selecting appropriate sources of such data.

The costs of deploying the UMP protocols will vary, depending on the features of the energy-efficiency program being evaluated, the participant characteristics, the desired levels of rigor and accuracy, and the frequency of evaluations. Thus, cost estimates for implementing the protocols are not

provided. Instead, the utilities and program administrators adopting the protocols should consider benchmarking their programs and gauging their EM&V budgets against those of other entities with experience in conducting EM&V for similar programs.

As a general rule, the level of EM&V effort—and expenditures—should be scaled to both the program being evaluated and the accuracy necessary to inform the decision for which evaluation results matter. The value of the information provided by the EM&V activity is determined by the resource benefits of the program and the particular policy and research questions the EM&V activity aims to address.

Evaluation resource requirements also depend on how often they are conducted. The frequency with which evaluations are performed depends on a number of considerations, including, but not limited to, the type and complexity of the measure and its expected contribution to portfolio savings, the of uncertainty about the savings, the stage in the life cycle of the program in question, and regulatory requirements. In light of these considerations, UMP has no specific recommendation about how often programs should be evaluated.

Moreover, UMP recognizes that even the lower-cost options provided in the UMP protocols may be impractical where resources are constrained or programs are small (such as those offered by small utilities). In these circumstances, program administrators may consider using deemed savings values from TRMs created by regional or state entities or evaluations of similar programs performed by other regional utilities. Where possible, program administrators may also consider other cost-saving measures, such as pooling EM&V resources and jointly conducting evaluations of similar programs through local associations, as has been done successfully in small utilities in California, Michigan, and the Pacific Northwest.

Next Steps

By the end of its second phase, the UMP will have produced protocols for measures accounting for the lion's share of energy savings in most portfolios of ratepayer-funded programs. But the work will very probably continue in several important dimensions such as:

1. Revising and enhancing the existing protocols based on the lessons from their actual implementation and new information.

2. Tracking and documenting the progress in the adoption of UMP and the manner of their adoption to gauge the project's effectiveness. The UMP team has already launched a survey of potential users of the available protocol to explore the users' awareness of and reactions to the protocols and how they are being implemented.

3. Expanding the list of measures and including additional ones such as residential new construction and strategic energy management in the commercial and industrial sectors, and cross-cutting methods such as top-down or macro-economic modeling methods.

4. Developing EM&V protocols for more measures that target natural gas end-uses.

5. Recognizing the need for standardized forms for reporting the savings from ratepayer-funded programs in a consistent manner, so that their impacts may be aggregated to evaluate the effects of energy efficiency on broader national policy objectives such as greenhouse gas reduction. A project has already been launched to investigate the application and usability of such forms on a limited basis by the member utilities of the Northeast Energy Efficiency Partnership (NEEP).

Investment in ratepayer-funded energy efficiency has grown tremendously. Conservation is being increasingly recognized as an effective instrument for furthering important environmental policy objectives such as carbon mitigation. These developments necessitate a more systematic and consistent approach to validating the impacts of energy efficiency. The UMP is a significant step in that direction.

The UMP protocols are the result of a large, collaborative effort by stakeholders in the energy-efficiency industry. The methods described in each protocol are the most commonly used approaches in the energy-efficiency industry for calculation and verification of savings for certain measures or programs. As such, they draw from the existing body of research and best practices for energy-efficiency program evaluation, measurement, and verification.

Program administrators and policymakers can adopt these methods with the assurance that they are consistent with commonly accepted practices and they have been vetted by technical experts in the field of energy program evaluation. If widely adopted, these protocols will help establish a common basis for assessing and comparing the performance and effectiveness of energy-efficiency policies and investments across programs, portfolios, and jurisdictions.